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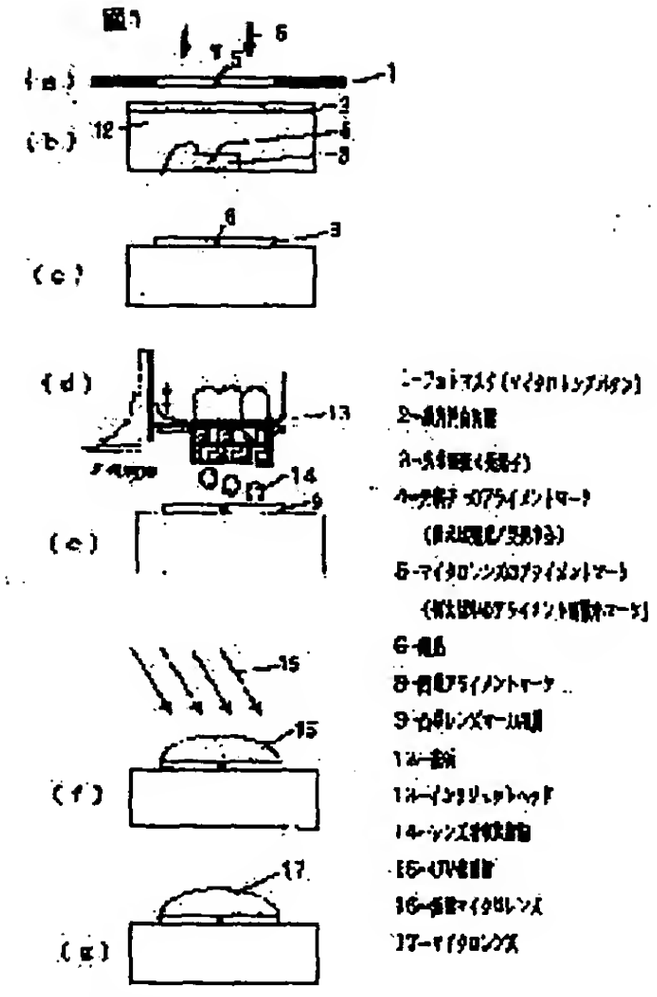
(71)Applicant : NIPPON TELEGR & TELEPH CORP <NTT>
(72)Inventor : ISHII YUZO

(54) MICROLENS FORMING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a microlens forming method capable of simply performing the alignment of the optical axis of an optical device (an optical element, an optical part or the like) with that of a microlens at a low cost.
SOLUTION: A photomask (1) having a microlens pattern for forming the microlens and an alignment mark pattern is used, and the alignment mark (5) of the microlens is aligned with the alignment mark (4) of the optical element by setting the alignment mark of the optical device having the optical element (3) to the light emitting or receiving center of the optical element to align the optical axis of the microlens with that of the optical device. A film (9) for a lens marker, to which the microlens pattern having an alignment mark (8) at the center thereof is transferred, is formed on a substrate (12), and a liquid resin for the microlens is injected on the film for the lens marker to form a liquid microlens which is, in turn, irradiated with UV rays to be cured to form the microlens.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] How to form a micro lens in the above-mentioned substrate front face of the optical equipment which a lightwave signal outputs and inputs to a light-corpuscle child through the substrate which lightwave signal light penetrates characterized by providing the following. The micro-lens pattern which specifies the portion which forms the above-mentioned micro lens. The alignment mark which set the alignment mark of another side and optical equipment as the above-mentioned light-corpuscle child's luminescence or light-receiving center, or was independently formed on the light-corpuscle child is prepared using the photo mask which has the alignment mark pattern formed in the interior of this pattern, and it is the alignment mark of the above-mentioned photo mask. The process which forms a photosensitive material film with equal above-mentioned micro-lens material and refractive index on the substrate which doubles the position of the above-mentioned photo mask and the above-mentioned optical equipment, and forms the above-mentioned micro lens by carrying out alignment of the alignment mark of the above-mentioned optical equipment. The process which forms in a center the film for lens markers which imprinted the micro-lens pattern which has an alignment mark by using the above-mentioned photo mask on the above-mentioned photosensitive material film, and exposing and developing negatives, the process which inject the liquefied resin for lenses and form a liquefied micro lens on the micro-lens pattern of the above-mentioned film for lens markers, and the process which irradiate UV light, make harden the micro lens of the shape of above-mentioned liquid, and form a micro lens.
[Claim 2] The micro-lens pattern which is the method of forming a micro lens in the above-mentioned substrate front face of the optical equipment which a lightwave signal outputs and inputs to a light-corpuscle child through the substrate which lightwave signal light penetrates, and specifies the portion which forms the above-mentioned micro lens, The photo mask which has the alignment mark pattern formed in the interior of this pattern is used. The alignment mark which set the alignment mark of optical equipment as the above-mentioned light-corpuscle child's luminescence or light-receiving center, or was independently formed on the light-corpuscle child is prepared. On the other hand, the alignment mark of the above-mentioned photo mask, By carrying out alignment of the alignment mark of the above-mentioned optical equipment The process which forms a photosensitive material film on the substrate which doubles the position of the above-mentioned photo mask and the above-mentioned optical equipment, and forms the above-mentioned micro lens, The micro-lens pattern which specifies the portion which uses the above-mentioned photo mask for the photosensitive material film formed on the above-mentioned substrate, and forms the above-mentioned micro lens, The process which imprints the alignment mark pattern formed in the interior of this pattern, The process which forms the film for lens markers which left the portion which carries out fault development of the above-mentioned photosensitive material film, eliminates the above-mentioned alignment mark imprinted by this photosensitive material film, and forms the above-mentioned micro lens, The liquefied resin for lenses is injected into the portion which forms the above-mentioned micro lens. The micro-lens formation method characterized by including at least the process which forms a liquefied micro lens, and the process which irradiates UV light, is made to harden the micro lens of the shape of above-mentioned liquid, and forms a micro lens.
[Claim 3] It is the micro-lens formation method characterized by the bird clapper from the material which carries out fault development of the above-mentioned photosensitive material film, eliminates an alignment mark in a claim 2, the film for lens markers which left the portion which forms a micro lens approaches the portion which forms the above-mentioned micro lens on the above-mentioned substrate front face, and is formed in the field of the outside of the portion which forms this micro lens, and has absorptivity to the wavelength of the above-mentioned lightwave-signal light.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the micro-lens manufacturing technology of optical equipment.
[0002]
[Description of the Prior Art] Drawing 6 shows an example of the conventional micro-lens manufacture method indicated by JP,2000-180605,A (Japanese Patent Application No. No. 358956 [ten to]). this conventional method should boil liquefied ultraviolet-rays (UV light) hardening resin ink-jet head 13 -- it injects on a substrate 12 as RI and a liquefied resin 14 for lenses, the place made to spheroidize with surface tension is stiffened by UV light irradiation 15, and a micro lens 21 is formed The injection capacity of liquefied ultraviolet-rays (UV light) hardening resin can be correctly controlled using a piezo driver element etc., and it is possible to produce the high micro-lens array of repeatability and a controllability. Moreover, since a lens can be direct formed on the arbitrary substrates 12, it is easy to unite a micro lens with optical parts, such as semiconductor laser, and a photo detector, an optical waveguide. The dropped liquefied resin depends on the relation of the surface tension of a liquefied resin and a substrate for a substrate and the angle to make, i.e., a contact angle, greatly. Although the relation of the surface tension of a liquefied resin and a substrate is determined by the shape of the viscosity of a resin, each temperature of a resin and a substrate, and surface type of a substrate etc., since a contact angle will be uniquely determined if those conditions are the same, applying as the manufacture method of a micro lens is possible. As a parameter showing the lens property of a micro lens, a focal distance, the F number, a lens diameter (diameter of opening), etc. are mentioned. In these lens parameters, the F number can be easily drawn from the contact angle of a resin, and the refractive index of a resin. That is, if the combination of the resin (a refractive index is known) which forms a predetermined contact angle, and a substrate is prepared, a micro lens with the desired F number is producible. Moreover, about a lens diameter, a contact angle is not based on injection capacity, but since it is fixed, it is controllable only by injection capacity.
[0003] In the above-mentioned conventional technology, it is possible to produce a micro lens with various lens properties simple. However, although this conventional technology is a method which produces one micro lens at a time and it is also possible to produce a micro-lens array collectively by forming an ink-jet head into a multi-nozzle, it depends for the alignment precision of a target position and a injection head on the resolution of the stage drive precision of equipment, and an observation system etc. greatly. That is, in order to raise the formation position accuracy of a micro lens, it is necessary to achieve highly precise-ization of equipment. Highly precise-ization of equipment means expensive rank-ization of equipment, and makes the manufacturing cost of a micro lens increased. Therefore, in order to manufacture a micro lens by the low cost, it is necessary for the formation position accuracy of a micro lens to consider as the manufacture method which is not influenced by equipment precision.
[0004] An example of the manufacture method of a micro lens that the formation position accuracy of the above-mentioned micro lens was proposed as the manufacture method which is not influenced for equipment precision by drawing 7 is shown [JP,62-83337,A (Japanese Patent Application No. No. 220375 [60 to])]. This is the method of forming the transparent resin (it being hereafter called the film for convex type lens markers) 24 of the shape of a disk which becomes exposure 6 and the portion which should develop negatives and should form the micro lens on a substrate 12 by patterning from a photopolymer 23 using a photo mask 22 about the photopolymer 23 prepared on the substrate 12. Since the transparent resin 24 of the shape of a disk which is this convex type lens marker is produced by the photo lithography technology using the above-mentioned photo mask 22 which has a micro-lens pattern, both the configuration of the film 24 for convex type lens markers, the accuracy of an array pitch, and its repeatability are high.
[0005] Since the shot position of the drop of liquefied UV light hardening resin 25 should just be on the above-mentioned film 24 for convex type lens markers when such a film 24 for convex type lens markers is formed on the

target substrate, position precision is eased sharply. Although the drop injected on the film 24 for convex type lens markers gets wet and spreads the film 24 top for convex type lens markers, a breadth stops at the periphery section and the shape of a globular form is formed naturally. Since the film 24 for convex type lens markers is circular, in accordance with the center and accuracy of a lens marker, the diameter of a micro lens 26 is further held correctly for a lens center by the path of the film 24 for convex type lens markers.

[0006] Here, alignment of a photo mask 22 is usually performed using the alignment mark formed in the mask. Although formed in portions other than the micro-lens pattern of a mask, alignment of this alignment mark is carried out as an alignment mark in which this was prepared in the evening-get side. Although it is the detailed pattern formed in the wiring layer in many cases as an alignment mark pattern prepared in a target side, an alignment mark pattern may be produced on optical parts (it is collectively called optical parts), such as chips, such as a light-corpuscle child, and an optical waveguide.

[0007] If loading precision of optical parts is not raised when the alignment mark is formed on the wiring layer in which optical parts were carried, the optical axis of optical parts and a micro lens will shift. Therefore, in order to double an optical axis, the mounting technology of highly precise optical parts will be needed, and a mounting increase in cost will be caused. Moreover, when forming an alignment mark in optical parts, in order to make it in agreement with the alignment mark by the side of a photo mask 22, the size of optical parts must be larger than the size of a micro lens enough. Although an alignment mark can also be prepared in a micro lens, it is not desirable to form a mark pattern in a light-transmission portion in order to bring about the influence of reflection, attenuation by scattering, etc. to the transmitted light.

[0008]

[Problem(s) to be Solved by the Invention] In the manufacture method of the conventional micro lens mentioned above, in order to be dependent on equipment precision and to form a highly precise micro lens, the position accuracy which trickles ultraviolet-rays hardening resin had to attain highly precise-ization of equipment, and had caused a raise in the cost of equipment, as a result the increase in the manufacturing cost of a micro lens. Moreover, although the technique of forming the disk-like lens marker on the evening-get substrate beforehand was proposed in order to ease the precision of the dropping position of a liquefied resin, some technical problems occurred about formation of an alignment mark with a lens marker and optical parts (optical equipment). For example, when the expensive loading equipment for carrying optical parts correctly was required, were having to form an alignment mark in the front face of optical parts, it was required for optical parts to be larger than a micro lens in order to form an alignment mark or the alignment mark was prepared in the micro lens, the light-transmission property was affected and there was a problem of the lens effect deteriorating.

[0009] The purpose of this invention is to solve the problem of the above-mentioned conventional technology and offer the micro-lens formation method which can carry out alignment of the optical-axis doubling of optical equipments (a light-corpuscle child, optical parts, etc.) and a micro lens by the low cost simply.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is considered as composition like a publication at a claim. namely, the optical equipment (a light-corpuscle child --) which a lightwave signal outputs and inputs to a light-corpuscle child through the substrate which lightwave signal light penetrates The micro-lens pattern which is the method of forming a micro lens in the above-mentioned substrate front faces, such as optical parts, and specifies the portion which forms the above-mentioned micro lens, The photo mask which has the alignment mark pattern formed in the interior of this pattern is used. The alignment mark which set the alignment mark of optical equipment as the above-mentioned light-corpuscle child's luminescence or light-receiving center, or was independently formed on the light-corpuscle child is prepared. On the other hand, the alignment mark of the above-mentioned photo mask, By carrying out alignment of the alignment mark of the above-mentioned optical equipment The process which forms a photosensitive material film with equal above-mentioned micro-lens material and refractive index on the substrate which doubles the position of the above-mentioned photo mask and the above-mentioned optical equipment, and forms the above-mentioned micro lens, By using the above-mentioned photo mask on the above-mentioned photosensitive material film, and exposing and developing negatives The process which forms in a center the film for lens markers which imprinted the micro-lens pattern which has an alignment mark, The liquefied resin for lenses is injected on the micro-lens pattern of the above-mentioned film for lens markers. It considers as the micro-lens formation method which includes at least the process which forms a liquefied micro lens, and the process which irradiates UV light, is made to harden the micro lens of the shape of above-mentioned liquid, and forms a micro lens.

[0011] if a micro lens is produced at such a process according to claim 1, optical-axis doubling of optical equipments (a light-corpuscle child or optical parts) and a micro lens will be markedly alike compared with the former, will become easy, and will become possible [forming a micro lens with a high position precision by the low cost]

[0012] Moreover, it is the method of forming a micro lens in the above-mentioned substrate front face of the optical equipment a lightwave signal outputs and inputs to a light-corpuscle child like through the substrate according to claim 2 which lightwave signal light penetrates. The micro-lens pattern which specifies the portion which forms the above-mentioned micro lens, The photo mask which has the alignment mark pattern formed in the interior of this pattern is used. The alignment mark which set the alignment mark of optical equipment as the above-mentioned light-corpuscle child's luminescence or light-receiving center, or was independently formed on the light-corpuscle child is prepared. On the other hand, the alignment mark of the above-mentioned photo mask, By carrying out alignment of the alignment mark of the above-mentioned optical equipment The process which forms a photosensitive material film on the substrate which doubles the position of the above-mentioned photo mask and the above-mentioned optical equipment, and forms the above-mentioned micro lens, The micro-lens pattern which specifies the portion which uses the above-mentioned photo mask for the photosensitive material film formed on the above-mentioned substrate, and forms the above-mentioned micro lens, The process which imprints the alignment mark pattern formed in the interior of this pattern, The process which forms the film for lens markers which left the portion which carries out fault development of the above-mentioned photosensitive material film, eliminates the above-mentioned alignment mark imprinted by this photosensitive material film, and forms the above-mentioned micro lens, The liquefied resin for lenses is injected into the portion which forms the above-mentioned micro lens, and it considers as the micro-lens formation method which includes at least the process which forms a liquefied micro lens, and the process which irradiates UV light, is made to harden the micro lens of the shape of above-mentioned liquid, and forms a micro lens.
[0013] Thus, it is effective in it becoming unnecessary to adjust the refractive index of the resin material of a lens marker and a micro lens, and the width of face of selection of the resin material for micro lenses becoming large by performing fault development according to claim 2, eliminating an alignment mark, and using the process which leaves the portion which forms a micro lens.
[0014] Moreover, the film for lens markers which left the portion according to claim 3 which carries out fault development of the above-mentioned photosensitive material film, eliminates an alignment mark in a claim 2 like, and forms a micro lens It considers as the micro-lens formation method which consists of material which approaches the portion which forms the above-mentioned micro lens on the above-mentioned substrate front face, and is formed in the field of the outside of the portion which forms this micro lens, and has absorptivity to the wavelength of the above-mentioned lightwave signal light.
[0015] By considering as the micro-lens formation method like the above-mentioned claim 3, the resin material for lens markers does not need to be transparent to operating wavelength, and when the light-corpuscle child is stationed in the shape of an array, it is effective in the ability to reduce the optical cross talk between adjacent channels by using the material which it dared have colored.
[0016]
[Embodiments of the Invention] <Gestalt 1 of operation> The gestalt of operation of the 1st of this invention is shown in drawing 1 . In drawing 1 , the manufacture method of a micro lens is the method of forming a micro lens in the front face of the above-mentioned substrate 12 in the optical equipment outputted and inputted to the light-corpuscle child 3 by whom die bond was done through the substrate 12 which lightwave signal light penetrates.
[0017] The micro-lens pattern which specifies the portion which forms a micro lens, The photo mask 1 [drawing 1 (a)] which has the alignment mark pattern (minute mark for main alignment) 5 formed in the interior of this pattern is used. The alignment mark 4 on the above-mentioned light-corpuscle child 3 (a light-corpuscle child's luminescence or light-receiving center), By carrying out alignment of the alignment mark 5 of the above-mentioned photo mask 1, the position of a photo mask 1 and optical equipment 3 is doubled, and optical-axis doubling of optical equipment 3 and a micro lens is performed [drawing 1 (b)]. After forming the photosensitive material film 2 with equal micro-lens material and refractive index on the substrate 12 which forms a micro lens and exposing the above-mentioned photosensitive material film 2 using a photo mask 1, the film 9 for convex type lens markers (film for lens markers which imprinted the micro-lens pattern) which has the concave alignment mark 8 is formed in a center by developing negatives [drawing 1 (c)]. On the micro-lens pattern of the film 9 for lens markers, the ink-jet head 13 [drawing 1 (d)] is used, the liquefied resin 14 for lenses is injection/Breathed out, [drawing 1 (e)] and the liquefied micro lens 16 are formed, UV light irradiation 15 is taken, the micro lens 16 of the shape of this liquid is stiffened, and [drawing 1 (f)] and a micro lens 17 [drawing 1 (g)] are formed.
[0018] Since the photosensitive material film 2 of the negative mold which the exposed part hardens is used for the micro-lens pattern (it is henceforth called the film for lens markers) which specifies the portion which forms a micro lens 17, the alignment mark which carried out forms, such as the shape of a cross joint or a disk, is formed in the core. Since this alignment mark is a shading portion, the existing concave alignment mark 8 corresponding to the alignment mark pattern to dent (hollow) is formed in the core of the film 9 for convex type lens markers. However, the portion of

the depression of this concave alignment mark 8 is closed by the process of injection/regurgitation of the drop of the liquefied resin 14 for lenses performed continuously, serves as the completely same solid phase as the film 9 for convex type lens markers, and can form a homogeneous micro lens. Here, when the refractive index of the film for convex type lens markers and the resin material for micro lenses was adjusted, optically, the interface was not able to become but the depression between the film 9 for lens markers and the concave alignment mark 8 was able to obtain the homogeneous and transparent micro lens.

[0019] <Gestalt 2 of operation> The gestalt of operation of the 2nd of this invention is shown in drawing 2 . In drawing 2 , a lens marker is formed using the photopolymer of the positive type from which the exposed portion is removed. By using the photopolymer of a positive type, the film 10 for lens markers (film for concave lens markers) of the configuration (it became depressed) where the micro-lens portion was dented is formed on the contrary [the gestalt 1 of the above-mentioned implementation]. The micro-lens pattern which specifies the portion which forms a micro lens, The photo mask 1 [drawing 2 (a)] which has the alignment mark pattern 5 formed in the interior of this pattern is used. By setting the light-corpuscle child's 3 alignment mark pattern as the light-corpuscle child's (optical equipment) 3 luminescence or light-receiving center, and carrying out alignment of the alignment mark pattern 5 of a photo mask 1 The position of a photo mask 1 and optical equipment 3 is doubled, and the substrate 12 in which photosensitive material film 2' of a positive type was formed is carried out exposure 6 using the photo mask 1 which has the above-mentioned micro-lens pattern [drawing 2 (b)]. Negatives are developed and the film 10 for concave lens markers which has the convex type alignment mark 7 is formed in the interior [drawing 2 (c)]. The process [drawing 2 (g)] which injects the liquefied resin 14 for lenses [drawing 2 (e)], forms liquefied micro-lens 16, carries out UV light irradiation 15 [drawing 2 (f)] hereafter using the ink-jet beef fat 13 [drawing 2 (d)], and forms a micro lens 17 is the same as the gestalt 1 of the above-mentioned implementation almost.

[0020] The alignment mark is formed in the core of a micro lens in order to double the position of a micro lens with a light-corpuscle child's luminescence/light-receiving center like [the gestalt 2 smell of this operation] the gestalt 1 of above-mentioned operation. In a development process, as shown in drawing 2 , this alignment mark turns into the minute convex type alignment mark 7, in order to remain without **********ing. However, since minute heights are covered by the injection process of the liquid resin performed continuously, these minute heights become transparent optically like the gestalt 1 of the above-mentioned implementation according to it by adjusting the refractive index of the resin material for lens markers, and the resin material for micro lenses. In addition, as for **, it is desirable on the film for concave lens markers to use a water-repellent high material as a resin material for lens markers.

[0021] <Gestalt 3 of operation> With the gestalt 3 of this operation, as shown in drawing 3 , it is not necessary to remove the convex type alignment mark 7 which was formed in the interior of the film 10 for concave lens markers in the case of drawing 2 , and to adjust the refractive index of the resin material of the film for concave lens markers, and a micro lens, and the formation method of the micro lens which can make large selection width of face of the resin material for micro lenses is stated.

[0022] As shown in drawing 3 (c), the substrate 12 in which photosensitive material film 2' of a positive type was formed is used. By carrying out alignment of the alignment mark pattern 5 of a photo mask 1, and the alignment mark pattern 4 on the light-corpuscle child 3 (luminescence/light-receiving center) After considering the light-corpuscle child's (optical equipment) 3 alignment as a photo mask 1, fault development is performed in the process which carries out exposure 6 and is developed. The convex type alignment mark 7 imprinted by photosensitive material film 2' of a positive type is removed, and film 10' for concave lens markers which specifies the edge by the side of the periphery of a micro-lens formation portion is formed. Next, the process [drawing 3 (g)] which injects the liquefied resin 14 for lenses, forms [drawing 3 (e)] and the liquefied micro lens 16, takes UV light irradiation 15, is stiffened and forms [drawing 3 (f)] and micro-lens 17 ** on film 10' for concave lens markers which is the portion which forms a micro lens is the same as the gestalten 1-2 of the above-mentioned implementation.

[0023] By considering as such a micro-lens formation method, it becomes unnecessary to adjust the refractive index of the resin material of a lens marker and a micro lens, and width of face of selection of the resin material for micro lenses can be made large. Moreover, when it does not need to be transparent and the light-corpuscle child is stationed in the shape of an array to operating wavelength as a resin material of the film for concave lens markers, the effect of reducing the optical cross talk between adjacent channels can also be expected by using the material which it dared have colored. However, generally, since a photosensitive material of a positive type (photolysis type) has few kinds, when actual results, such as the reliability of a resin, have priority, the direction which uses a negative-mold photopolymer is a best policy. In addition, an example of the mask pattern for lens marker production used with the gestalten 1-3 of the above-mentioned implementation was shown in drawing 5 . You may be a cross-like although drawing 5 showed the minute disk-like thing as an alignment mark.

[0024] <Gestalt 4 of operation> As shown in drawing 4 , in the gestalt 4 of this operation, by forming the film 11 for

ring-like lens markers explains the case where a micro lens is produced, using the photo mask 1 [drawing 4 (a)] which has the ring-like lens marker pattern 19. Although the point which carries out patterning using the photopolymer of a positive type is the same as the gestalt 2 of the above-mentioned implementation, when the resin material for micro lenses is dropped, it differs in that the appearance of a micro lens is determined on the edge of the outside of the film 11 for ring-like lens markers.

[0025] When the resin for micro lenses is dropped, in order to stop the breadth, the device of using a water-repellent material or thickening thickness of a lens marker was required for the film 10 (drawing 2) for concave lens markers. These are factors which make a production process restrict and difficulty-ize, and it is missing and they have few [a edge] things which a resin spreads on the film for lens markers by the dry area etc. By the film 10 (drawing 2) for concave lens markers, and the film 9 (drawing 1) for convex type lens markers, the film 9 for convex type lens markers can form a micro lens with sufficient repeatability. That is, the film 11 for ring-like lens markers shown in the form 4 of this operation has the good point of both sizes of the goodness of the repeatability of micro-lens production which the film 9 for convex type lens markers has, and the alternative of the resin material for micro lenses which the film 10 for concave lens markers has.

[0026] Also in the film 11 for ring-like lens markers, the alignment mark of a micro-lens core is removable like the form 3 of the above-mentioned implementation with fault development. Since fault development also of the ring portion is similarly carried out in that case, it needs to be cautious of the design of ring width of face. In addition, in the form of the above-mentioned implementation, although the ink-jet method has been taken up to the method which injects a liquefied resin, it does not limit to an ink-jet method, and if it is the method which can trickle a minute quantity of a drop with a sufficient controllability, it can apply, for example, this can also use a dispenser method. Moreover, in the form of the above-mentioned implementation, although the thing of a single channel has been taken up as a light-corpuscle child, this is not limited to a single channel. In the light-corpuscle child array arranged a single dimension or in the shape of-dimensional [2], the micro-lens formation method of the above-mentioned this invention is completely applicable similarly.

[0027]

[Effect of the Invention] According to the micro-lens formation method of having used the property in which the drop of the minute amount of this invention became globular form-like on a substrate In the mask pattern of the lens marker used in order to raise the diameter of a micro lens, and the accuracy and repeatability of an array array It becomes possible by forming a minute alignment pattern in the core of a micro lens, and carrying out alignment of this and a light-corpuscle child's (optical equipment) luminescence/light-receiving center to double those opticals axis easily. It is not necessary for it to be used in order to double the optical axis of a light-corpuscle child and a micro lens, and to form a special alignment mark as a lens marker used in order to raise the formation position precision, and to carry a light-corpuscle child using the high-class mounting methods, such as a flip chip, and to newly prepare an alignment mark in a chip front face. Furthermore, a chip appearance is small, and since it is settled in the projection size of a micro lens, when an alignment mark cannot be formed, the micro lens whose optical axis suited to the light-corpuscle child can be produced by the low cost. Moreover, although the lens marker used for the alignment of a micro lens and a light-corpuscle child is in a light-transmission field, it can remove optically or physically and can prevent the increase in an unnecessary interface.

[Translation done.]

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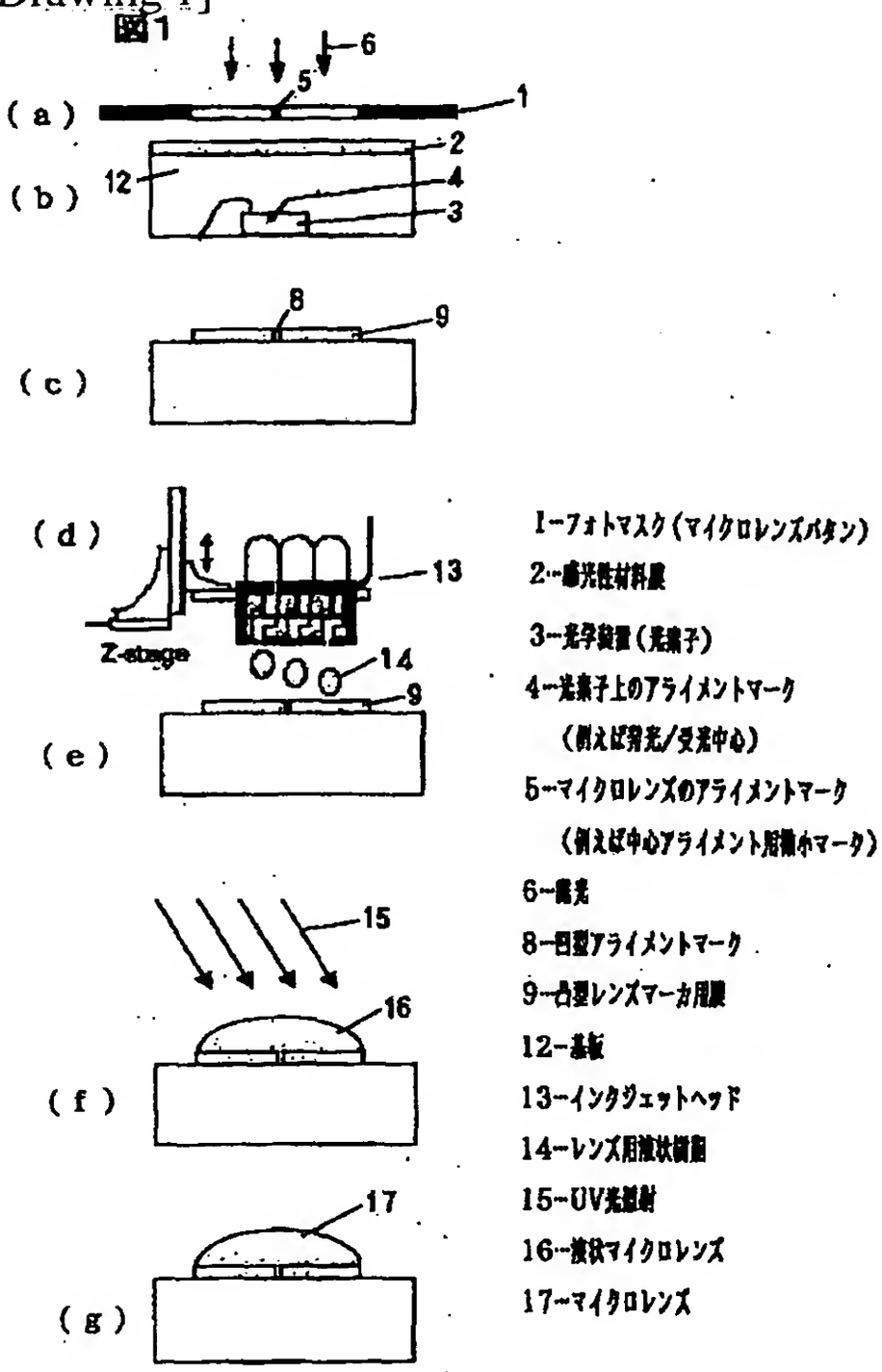
DRAWINGS

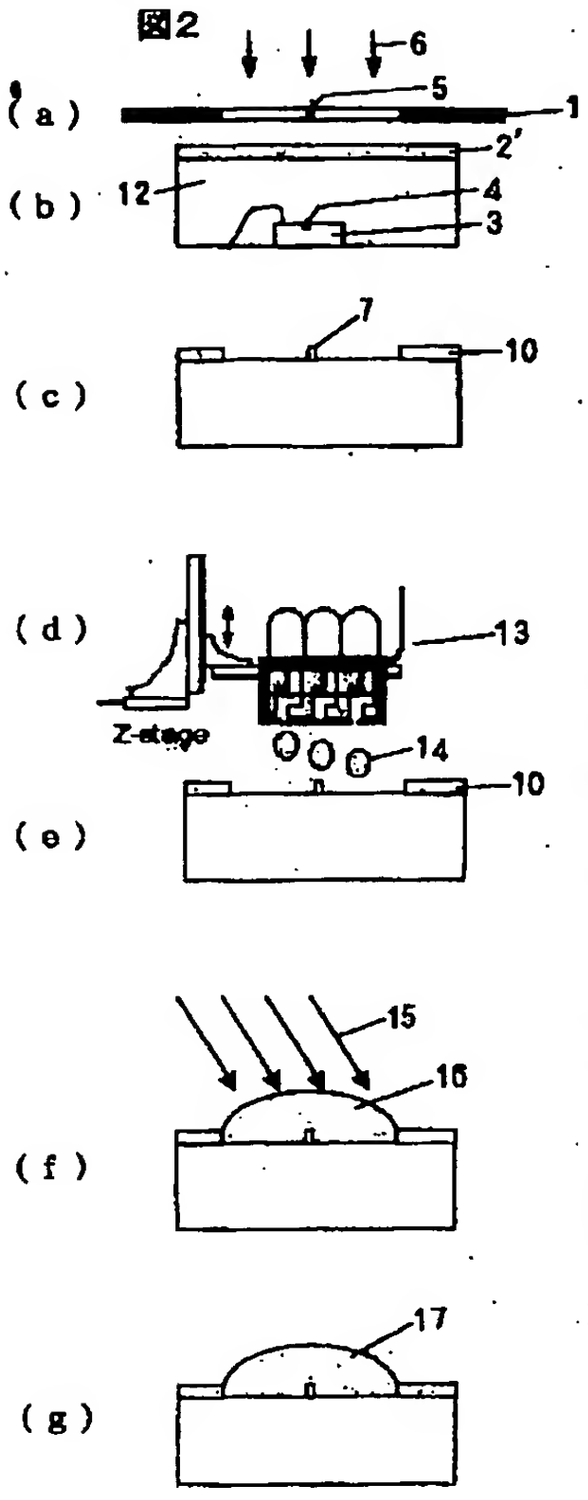
[Drawing 1]



1-フォトマスク(マイクロレンズパタン)
2-感光性材料層
3-光学装置(光素子)
4-光素子上のアライメントマーク
(例えば発光/受光中心)
5-マイクロレンズのアライメントマーク
(例えば中心アライメント用補助マーク)
6-露光
8-凹型アライメントマーク
9-凸型レンズマーカ用膜
12-基板
13-インクジェットヘッド
14-レンズ用液状樹脂
15-UV光照射
16-液状マイクロレンズ
17-マイクロレンズ

[Drawing 2]

図2



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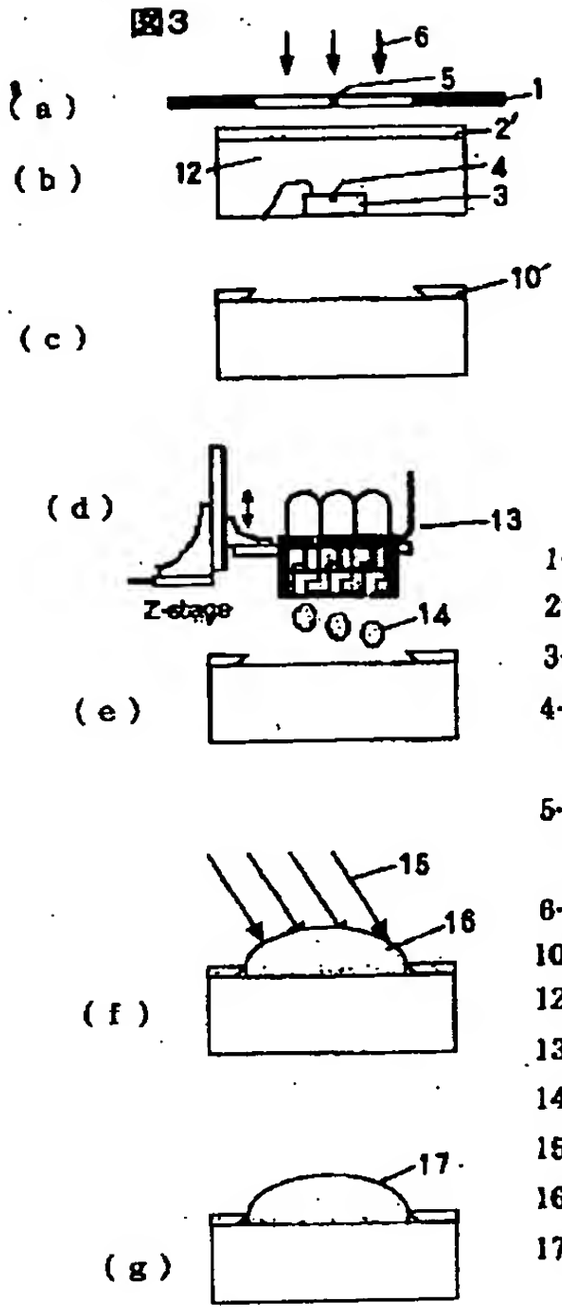
5-マイクロレンズのアライメントマーク
(例えば中心アライメント用凹みマーク)
6-露光
7-凸型アライメントマーク
10-凹型レンズマーカ用膜
12-基板
13-インクジェットヘッド
14-レンズ用液状樹脂
15-UV光照射
16-液状マイクロレンズ
17-マイクロレンズ

[Drawing 3]

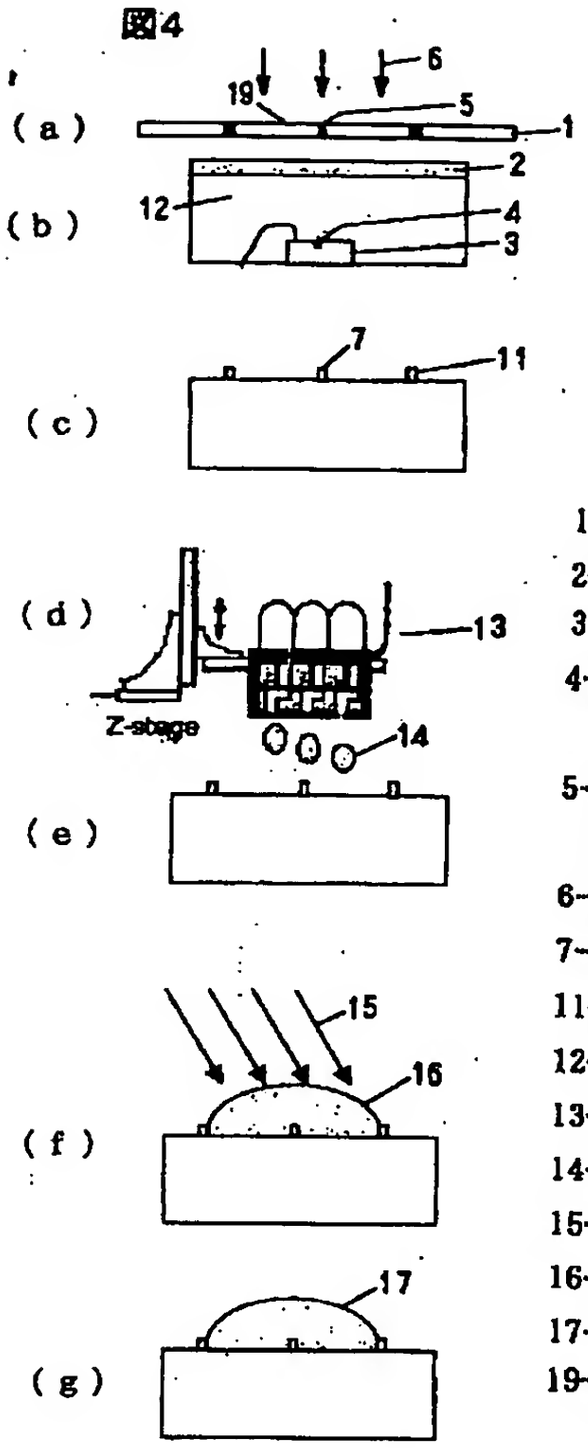
図3



1-フォトマスク(マイクロレンズパタン)
2' -感光性材料膜
3-光学装置(光源子)
4-光源子上のアライメントマーク
(例えば発光/受光中心)
5-マイクロレンズのアライメントマーク
(例えば中心アライメント用微小マーク)
6-露光
10' -凹型レンズマーカ用膜
12-基板
13-インクジェットヘッド
14-レンズ用液状樹脂
15-UV光硬化材
16-液状マイクロレンズ
17-マイクロレンズ

[Drawing 4]

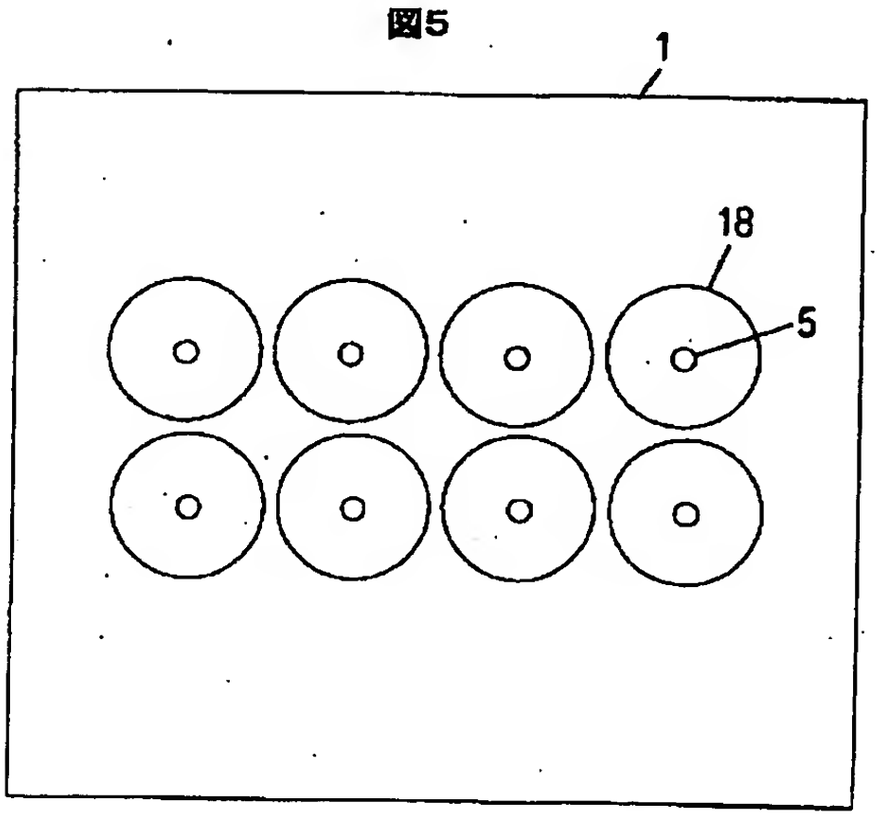
図4



1--フォトマスク(マイクロレンズパタン)
2--感光性材料膜
3--光学装置(光素子)
4--光素子上のアライメントマーク
(例えば発光/受光中心)
5--マイクロレンズのアライメントマーク
(例えば中心アライメント用微小マーク)
6--露光
7--凸型アライメントマータ
11--リング状レンズマーカ用膜
12--基板
13--インクジェットヘッド
14--レンズ用液状樹脂
15--UV光照射
16--液状マイクロレンズ
17--マイクロレンズ
19--リング状レンズマーカパタン

[Drawing 5]

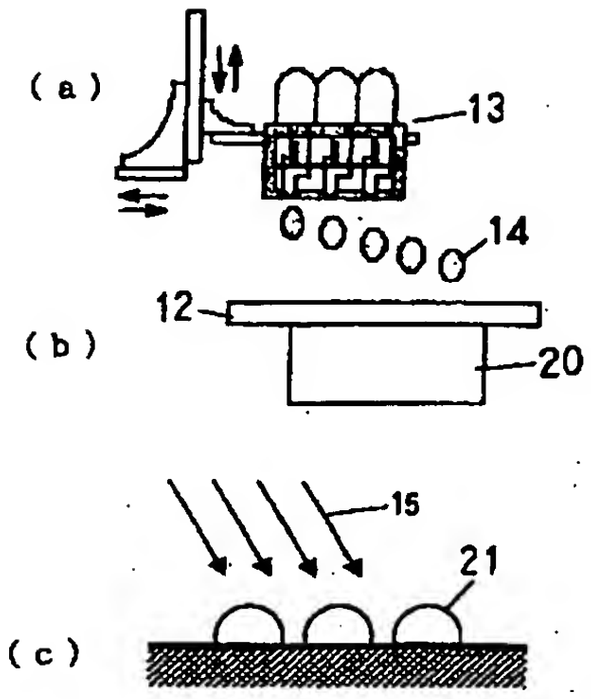
図5



1--フォトマスク(マイクロレンズパタン)
5--マイクロレンズのアライメントマーク
18--レンズマーカ作製用マスクパタン

[Drawing 6]

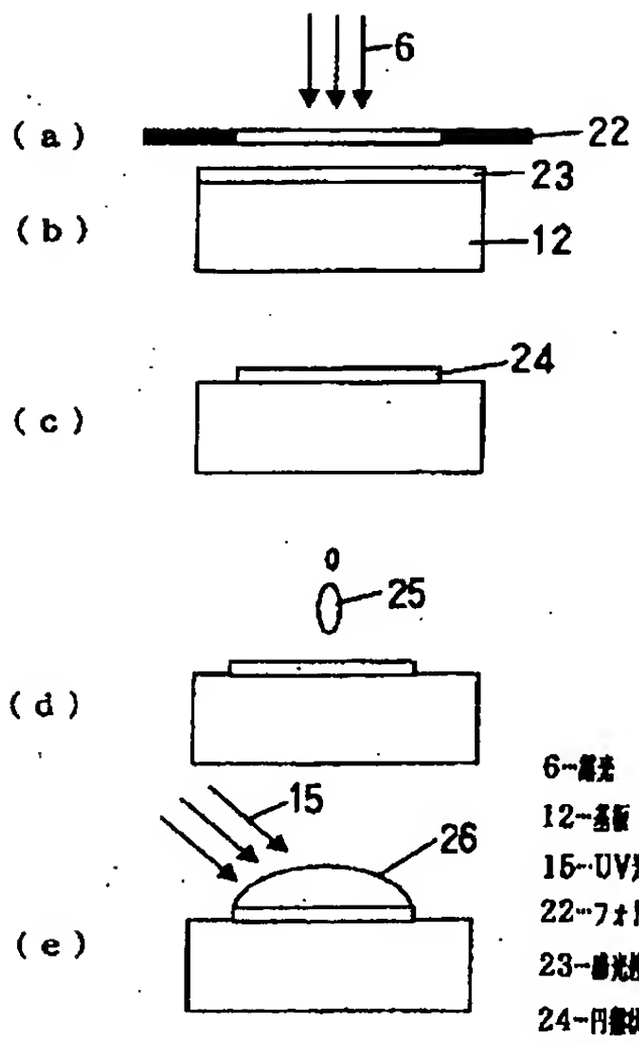
図6



12-基板
13-インクジェットヘッド
14-レンズ用液状樹脂
15-UV光照射
20-ステージ
21-マイクロレンズ

[Drawing 7]

図7



6-露光
12-基板
15-UV光照射
22-フォトマスク(マイクロレンズパタン)
23-感光性樹脂
24-円錐状の透明樹脂
(凸型レンズマーカ用量)
25-液状UV光硬化樹脂
26-マイクロレンズ

[Translation done.]